Evaluation of Nutritive Value of Forages Grown around Van Lake

Mehmet Akif KARSLI[1] Nihat DENEK[2] Suphi DENİZ[1] Akif Şaban GÜNDÜZ[3]

[1]Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Hayvan Besleme ve Beslenme Hastalıkları ABD, VAN
[2]Harran Üniversitesi Veteriner Fakültesi Hayvan Besleme ve Beslenme Hastalıkları ABD, ŞANLIURFA
[3]Yüzüncü Yıl Üniversitesi Sağlık Bilimleri Enstitüsü, VAN

SUMMARY

The aim of this study was to evaluate ruminal DM and N degradation kinetics of alfalfa, sainfoin, and grass hays collected at three different areas around Van lake by using in situ technique. Alfalfa, sainfoin, and grass hays were collected from three different location around Van lake, namely Van, Erciş, and Tatvan areas. To determine the chemical compositions of forages, samples of alfalfa, sainfoin and grass hays were analyzed for OM, NDF, ADF, CP, and ADIN concentrations. To estimate in situ degradation kinetics and fractions of N, three mature fistulated rams fed ground alfalfa-grass hay containing 10.75 % CP and 53.5 % NDF were used for incubation of samples in this study. Samples were incubated in the rumen of rams for periods of 0, 3, 6, 12, 24, and 48 h. In general, the concentrations of OM, ADF and ADIN-N were significantly higher, but the concentration of CP was significantly lower (P<0.05) in sainfoin hays compared with alfalfa hays. While the concentration of CP was significantly greater, the concentration of ADIN-N was significantly less in alfalfa hays than those of grass hays (P< 0.05). The concentrations of OM and ADF did not differ between alfalfa and grass hays. Sainfoin hays had significantly higher (P<0.05) OM and CP concentrations compared with those of grass hays. There were no significant differences between sainfoin and grass hays on the concentrations of ADF and ADIN-N. Alfalfa hays had significantly higher (P< 0.05) in situ ruminal DM degradability compared with grass hays and CP degradability compared with sainfoin and grass hays after 48-h incubation. The rate of CP degradation was the highest in alfalfa collected from Van area and the lowest in sainfoin collected from Erciş area among all forage samples collected from three different areas. The effects of location on parameters evaluated were not consistent. The highest NDP and escape protein as percentage of total CP were observed with grass hays. Alfalfa hays seems to have the best nutritive value among forages evaluated in this study.

Key Words: *Forages, DM degradability, CP degradability.*

Van gölü Havzasında Üretilen Kuru Otların Besleyici Değerinin Araştırılması

ÖZET

Bu çalışma da, Van gölü havzasından toplanan yonca, korunga ve çayır kuru otlarının in situ naylon kese yöntemiyle KM ve HP yıkılım kinetiklerinin belirlenmesi amaçlanmıştır. Yonca, korunga ve çayır kuru otları Van, Erciş ve Tatvan olmak üzere Van gölü havzasındaki üç değişik bölgeden toplanmıştır. Çalışmada yem örneklerinin OM, NDF, ADF, HP ve ADIN-N içerikleri belirlenmiştir. In situ naylon kese yıkılım değerleri ve azotun fraksiyonlarınnın belirlenmesi için, % 10.75 HP ve 53.5 NDF içeren yonca ve çayır kutru otu tüketen 3 adet rumen fistüllü koç kullanılmıştır. Örnekler 0, 3, 6, 12, 24 ve 48 saat süreyle koçların rumeninde inkube edilmiştir. Korunga örneklerinin OM, ADF ve ADIN-N içerikleri yonca örneklerine oranla önemli derecede yüksek (P< 0.05), fakat HP içeriği önemli derecede düşük (P< 0.05) bulunmuştur. Yonca örneklerinin HP içeriği kuru ot numunelerine oranla önemli derecede yüksek bulunurken, ADIN-N içeriklerinin düşük olduğu gözlemlenmiştir (P< 0.05). Yonca ve kuru otun OM ve ADF içerikleri benzer bulunmuştur. Korunga örneklerinin OM ve HP içerikleri kuru ota oranla önemli derecede yüksek (P< 0.05), ADF ve ADIN-N içerikleri ise benzer bulunmuştur. 48 saat inkubasyon süresi baz alındığında, yonca örneklerinin KM yıkılım bakımından kuru ottan; HP yıkılımı bakımından ise hem kuru ot hem de korungadan daha iyi yıkımlandığı gözlenmiştir (P< 0.05). Bütün örnekler arasında, Van bölgesinden toplanan yonca örnekleri, rumende en yüksek yıkılım hızına sahipken, Erciş bölgesinden toplanan korunga örnekleri en düşük rumen yıkılım hızına sahip olarak bulunmuştur. Bölgenin incelen parametreler üzerine etkisi bütün inkubasyon süreleri için belirgin olmamıştır. Rumende yıkımlanamayan ve by-pass protein oranı bakımında en yüksek değer kuru ottan elde edilmiştir.

Bu çalışmada, incelenen kuru otlar arsında, kuru yoncanın en yüksek besleyici değere sahip olduğu kanısına varılmıştır.

Anahtar Kelimeler: *Kaba Yem, KM Yıkılımı, HP Yıkılımı*

INTRODUCTION

Because ruminant animals possess rumen microbes, which can digest cellulose and use NPN to produce high quality microbial protein, ruminants are the predominant forage utilizer among animals (22). Forages provide 83% of the protein requirements of beef cattle and 90% of the protein requirement of sheep (12).

Protein requirement of animals were used to be calculated based on crude protein concentrations of diets. However, studies have shown that addition of escape protein into diets of fast growing ruminants and high producing dairy cows have resulted in an improvement in animal performance, indicating that crude protein system is lacking in terms of meeting the protein requirements of animals. Therefore, metabolizable protein system was introduced (17) to more accurately and priciously meet the protein requirements of ruminant animals.

Forage protein serves as a source of metabolizable protein to the ruminants by providing both ruminally degradable protein for microbial growth and some ruminally undegradable protein for intestinal digestion (2). Because of rapid and extensive degradation of forages in the rumen (3), escape protein concentration of forages are usually low (17). However, degradation rate and thus, escape protein concentrations vary among legumes and grasses, even within

legume and grass species (3). In addition to forage species, factors such as temperature and drought have been reported to affect protein in forages (6). Therefore, protein fractions of similar forage species may differ from one location to another location.

The objective of this study was to evaluate ruminal dry matter and nitrogen degradation kinetics and determine the protein fractions by using in situ technique in alfalfa, sainfoin, and grass hays collected at tree different areas around Van lake.

MATERIALS AND METHODS

Alfalfa and sainfoin, and grass hays used in this study were mature materials collected at three different location around Van lake, namely Van, Erciş, and Tatvan areas. Forages were collected from 10 villages for each location and forage specie. Two samples for each location and forage specie (forages collected from five villages combined on equal weight basis to obtain one sample) were obtained to reduce to number of sample used in *in situ* dacron bag study.

To determine the chemical compositions of forages, oven-dried samples of alfalfa, sainfoin and grass hays were ground to pass through a 1-mm screen and then analyzed for dry matter (DM), organic matter (OM) (1), neutral detergent fiber (NDF) (20), acid detergent fiber (ADF) (11), crude protein (CP) (1), and acid detergent insoluble nitrogen (ADIN) (11) concentrations.

To estimate *in situ* degradation kinetics and fractions of N, oven-dried samples of alfalfa, sainfoin and grass hays collected from three different locations, were ground to pass through a 2-mm screen. Approximately 2 g of each forage sample was weighed into a bag with internal dimensions of 13 x 7 cm; therefore, the ratio of sample weight to exposed bag surface area was approximately 12.5 mg/cm^2. Bags used were constructed of Dacron polyester having an average pore size of 50 microns. Suspension of bags in the rumen was accomplished by tying of bags onto tygon tubing with nylon string. Eight bags were affixed to each tygon tubing.

Three mature fistulated Morkaraman rams (averaging 55 kg) fed ground alfalafa-grass hay containing 10.75 % CP and 53.5 % NDF were used for incubation of samples in Dacron bags in this study. Alfalfa-grass hay was offered 1.25 x maintenance level of rams. Samples in Dacron bags were placed in the rumen of rams and incubated for the periods of 0, 3, 6, 12, 24, and 48 h. Two bags of samples for each specie were inserted into the rumen of each ram for each incubation time. Thereby, a total of 12 bags for each forage and incubation time were utilized *in situ* degradation study. After the removal of bags from the rumen, bags were washed under running water in a small washing machine for about 15 min. Then, all bags were dried for 24 h at 65 °C and DM recovery was determined. Undigested forage residues were analyzed for nitrogen by the micro-Kjeldahl procedure (1).

Kinetic parameters associated with the disappearance of N from bags were estimated from a one-pool version of Mertens' (15) discrete lag model of cell wall digestion.

Modification of the model by Wechsler (21), which allows estimation of both digestion and lag functions from a single formula, were also incorporated. Model estimates of the pool size, rate constant (k) and discrete lag time of the potentially digestible N in each sample were obtained by fitting recovery data to model, using nonlinear regression analysis (18).

Loss of Dm from bags caused by exposure of substrate to the digestive action of the rumen and the washing process that followed resulted in the partitioning of N in each of the forage into three fractions: 1) soluble fractions of N (WSP) were determined as the differences between initial N content and amounts of N recovered in 0 time-incubation; 2) potentially digestible fractions of N (PDP) were determined as 100 - (non-digestible fraction and water soluble fractions of N); 3) non-digestible fractions of N (NDP) were determined as the differences between initial N content and amount of N recovered after 48 h incubations of samples in the rumen (10,14)A modified technique reported by Mullahey et al. (16) was used to determine the percentage of forage protein that escaped ruminal degradation.

The proportion and concentration of total protein which would escape ruminal digestion were calculated as total residual N remaining following 12-h incubation, adjusted for the indigestible N (ADIN) using following equations:

Escape Protein Percentage (EPP), % of total protein = (Total residual N * ADIN of total residue) / (Total plant-N) x 100

Escape Protein Concentrations (EPC), g/kg-1 DM = 6.25 x (Total residual N - ADIN of total residue).

Statistical Analysis of Data

Results were subjected to analysis of variance using General Linear Model procedure of SAS (18). Mean treatment differences were determined by Duncans t-test with a level of statistical significance of 5% (19).

RESULTS AND DISCUSSION

Chemical compositions of forages collected from three different areas are presented in Table 1. Location where samples were collected did not affect the OM and ADIN-N concentrations of forages. Acid detergent fiber and CP concentrations of forages were affected by location. Acid detergent fiber concentrations of sainfoin samples collected from Tatvan area were significantly greater ($P< 0.05$) compared with those of sainfoin samples collected from Van and Erciş areas. While alfalfa samples collected from Van area had significantly greater CP concentrations than those of alfalfa collected from Erciş area, grasses collected from Erciş area had significantly higher ($P< 0.05$) CP concentrations compared with those of grasses collected from Tatvan and Van areas. The concentrations of OM, ADF and ADIN-N were significantly higher, but the concentration of CP was significantly lower ($P< 0.05$) in sainfoin hays compared with alfalfa hays. While the concentration of CP was significantly greater, the concentration of ADIN-N was significantly less in alfalfa hays than those of grass hays ($P< 0.05$). The concentrations of OM and ADF did not differ between alfalfa and grass hays. Sainfoin hays had significantly higher ($P< 0.05$) OM and CP concentrations compared with those of grass hays. There were no significant differences between sanfoin and grass hays on the concentrations of ADF and ADIN-N.

Table 1. Chemical composition of forages collected from three different areas.

	Van area			Tatvan area			Erciş area		
Items% ofDM	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass
DM	91.5 ^{ab}	91.4 ^{ab}	91.0 ^{ab}	91.0 ^{ab}	91.1 ^{ab}	91.4 ^{ab}	90.5 ^{b}	90.3 ^{b}	92.6 ^{a}
OM	90.0 ^{b}	92.5 ^{a}	90.0 ^{b}	90.1 ^{b}	91.9 ^{a}	89.7 ^{b}	89.6 ^{b}	92.1 ^{a}	90.3 ^{b}
NDF	48.3 ^{e}	53.2 ^{cde}	60.8 ^{a}	50.8 ^{de}	57.1 ^{abc}	59.7 ^{ab}	53.0 ^{cde}	54.8 ^{bcd}	58.2 ^{ab}
ADF	30.6 ^{cd}	34.8 ^{bcd}	35.3 ^{bc}	31.0 ^{cd}	41.3 ^{a}	33.0 ^{bcd}	30.2 ^{d}	36.7 ^{b}	32.1 ^{bcd}
CP	13.4 ^{a}	9.6 ^{c}	7.7 ^{e}	12.6 ^{ab}	9.9 ^{c}	7.3 ^{e}	11.9 ^{b}	9.4 ^{cd}	8.7 ^{d}
ADIN-N, % of total N	13.6 ^{cd}	22.2 ^{a}	22.3 ^{a}	15.3 ^{bcd}	20.3 ^{ab}	22.5 ^{a}	11.2 ^{d}	21.3 ^{a}	18.1 ^{abc}

$^{a\,b\,c\,d\,e}$ Means in same rows with different superscripts diffrer (P< 0.05).

Table 2. In situ DM degradation of forages collected from three different areas.

	Van area			Tatvan area			Erciş area		
Incubation Times, h	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass
0	34.4 ^{a}	32.1 ^{ab}	26.7 ^{c}	30.6 ^{abc}	29.4 ^{bc}	28.0 ^{bc}	31.9 ^{ab}	28.1 ^{bc}	28.3 ^{bc}
3	39.5 ^{a}	36.3 ^{abc}	31.8 ^{c}	36.3 ^{abc}	35.1 ^{abc}	31.7 ^{c}	35.0 ^{abc}	36.8 ^{ab}	33.7 ^{bc}
6	46.6 ^{a}	44.2 ^{abc}	36.3 ^{de}	45.8 ^{ab}	40.3 ^{bcde}	33.2 ^{e}	41.5 ^{abcd}	42.7 ^{abc}	39.0 ^{cde}
12	56.4 ^{a}	52.5 ^{abc}	45.7 ^{d}	55.5 ^{ab}	50.3 ^{bcd}	47.7 ^{d}	57.6 ^{a}	48.4 ^{cd}	48.7 ^{cd}
24	63.6 ^{a}	58.7 ^{abc}	53.3 ^{c}	61.6 ^{ab}	56.1 ^{bc}	54.5 ^{c}	61.1 ^{ab}	55.1 ^{bc}	58.1 ^{abc}
48	66.9 ^{a}	62.0 ^{ab}	57.2 ^{c}	65.0 ^{ab}	60.2 ^{ab}	58.2 ^{c}	65.1 ^{ab}	60.5 ^{ab}	63.4 ^{ab}

$^{a\,b\,c\,d\,e}$ Means in same rows with different superscripts diffrer (P<0.05) .

Table 3. In situ CP degradation of forages collected from three different areas.

	Van area			Tatvan area			Erciş area		
Incubation Times, h	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass
0	46.9 ^{ab}	34.9 ^{ef}	31.3 ^{f}	40.8 ^{cd}	36.9 ^{de}	42.3 ^{bc}	50.3 ^{a}	43.7 ^{bc}	51.0 ^{a}
3	50.8 ^{c}	53.6 ^{bc}	41.4 ^{de}	59.5 ^{a}	53.8 ^{bc}	36.7 ^{e}	56.5 ^{ab}	54.5 ^{bc}	39.9 ^{de}
6	70.8 ^{a}	63.0 ^{b}	46.3 ^{d}	71.0 ^{a}	58.1 ^{bc}	47.7 ^{d}	63.3 ^{b}	61.5 ^{b}	54.9 ^{c}
12	74.5 ^{a}	68.0 ^{bc}	53.0 ^{f}	74.7 ^{a}	66.3 ^{cd}	52.7 ^{f}	72.8 ^{ab}	62.1 ^{de}	60.0 ^{e}
24	79.9 ^{a}	73.2 ^{c}	57.9 ^{e}	78.6 ^{ab}	69.3 ^{cd}	61.7 ^{e}	73.9 ^{bc}	67.8 ^{d}	68.7 ^{cd}
48	82.1 ^{a}	73.2 ^{b}	64.5 ^{c}	82.4 ^{a}	74.7 ^{b}	63.2 ^{c}	80.9 ^{a}	73.5 ^{b}	73.7 ^{b}

$^{a\,b\,c\,d\,e\,f}$ Means in same rows with different superscripts diffrer (P< 0.05).

Table 4. In situ ruminal CP degradation kinetics and fractions of CP inforages collected from three different areas.

	Van area			Tatvan area			Erciş area		
Items	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass	Alfalfa	Sainfoin	Grass
k, h^{-1}	.1301 ^{a}	.122 ^{a}	.07 ^{ab}	.113 ^{a}	.122 ^{a}	.093 ^{ab}	.079 ^{ab}	.054 ^{b}	.103 ^{ab}
Lag time, h	2.38 ^{b}	1.70 ^{b}	1.78 ^{b}	2.83 ^{ab}	3.41 ^{ab}	2.34 ^{b}	4.63 ^{a}	2.24 ^{b}	1.67 ^{b}
WSP	46.9 ^{ab}	34.9 ^{ef}	31.3 ^{f}	40.8 ^{cd}	36.9 ^{de}	42.3 ^{bc}	50.3 ^{a}	43.7 ^{bc}	51.0 ^{a}
PDP	41.23 ^{a}	22.83 ^{c}	29.54 ^{c}	31.27 ^{bc}	27.28 ^{cd}	36.99 ^{ab}	38.66 ^{a}	29.97 ^{c}	36.32 ^{ab}
NDP	17.90 ^{d}	26.80 ^{c}	35.46 ^{b}	17.61 ^{d}	24.97 ^{c}	41.05 ^{a}	19.08 ^{d}	26.41 ^{c}	26.31 ^{c}
EPP	21.93 ^{bc}	20.24 ^{c}	33.48 ^{a}	21.22 ^{c}	20.57 ^{c}	37.77 ^{a}	22.81 ^{bc}	24.75 ^{bc}	26.82 ^{b}
EPC	28.9 ^{a}	19.4 ^{d}	25.9 ^{abc}	26.9 ^{abc}	20.2 ^{d}	27.2 ^{ab}	27.1 ^{ab}	23.5 ^{bcd}	22.9 ^{cd}

$^{a\,b\,c\,d\,e}$ Means in same rows with different superscripts diffrer (P< 0.05).

As expected, alfalfa hays had higher CP and lower ADIN-N concentrations compared with sainfoin and grass hays, which are in agreement with the findings of Coşkun et al. (9) and NRC (17). However, while the concentrations of CP were at lower, concentrations of ADIN-N were at upper edge of values reported in literature (9,13, 17, 23). This lower CP and higher ADIN-N concentrations most likely resulted in leaf loss during drying and grinding process, maturity differences, and alfalfa variety used in present study.

Location where forage samples were collected had no effect on in situ ruminal DM digestibility at all incubation times, except 48-h incubation time (Table 2, Figure 1).Grasses collected from Erciş area had significantly greater (P< 0.05) DM digestibilities than those of grasses collected from Tatvan and Van areas. Dry matter digestibilities at 0-h incubation, which represent the DM lost due to washing process were the highest in alfalfa and the lowest in grass samples after 12, 24, and 48-h incubations (P< 0.05). However, DM digestibilities of grasses collected from Erciş

area were similar with those of alfalfa samples after 24 and 48-h incubations in the rumen. Dry matter digestibilities of sainfoin samples were in between at all incubation times. Among all forages examined, while alfalfa samples collected from Van area had the highest, grasses collected from Van area had the lowest in situ ruminal DM digestibilities at all incubation times.

Effect of location on DM degradabilities was observed with only grasses. This difference could be due to two reasons; 1) Grass species may be different among the areas, because warm season grasses have long been recognized for their low digestibility (6). 2) This difference could be due to maturity differences in harvesting among grasses, which is also associated with low digestibility (4).

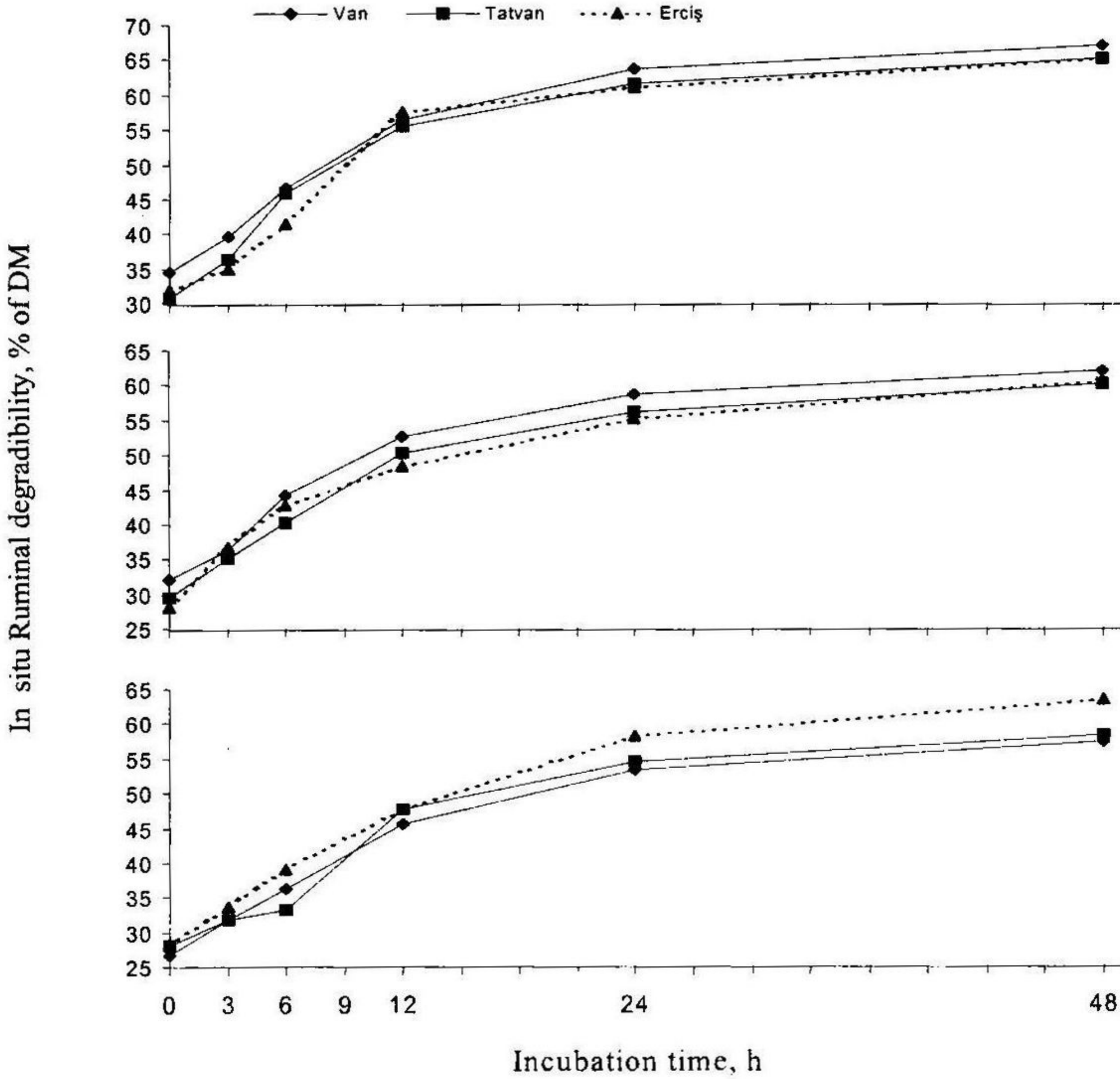

Figure 1. Asymptote of DM degradation curve.

Alfalfa hays had significantly higher in situ ruminal DM degradability compared with grass hays, which is in agreement with literature. Differences in digestibility between legumes and grasses have been well documented, with grasses normally showing high cell wall concentrations and a more rapid accumulation of lignin, and thus a more rapid decline in digestibility with maturity (4, 5).

Similar to DM degradability, whereas in situ CP degradabilities of alfalfa and sainfoin hays were consistently not affected by location, grass samples collected from Erciş area had significantly greater ($P< 0.05$) in situ CP degradabilities compared with those of grass samples collected from Van and Tatvan areas at all incubation times, except 3-h incubation time (Table 3). Alfalfa hays had the highest and grass hays had the lowest in situ ruminal CP degradabilities at all incubation times ($P< 0.05$) when forage species were compared. The in situ ruminal CP degradability of sanfoin hays were in between.

Location of forages collected had no significant effect on rate of CP degradation of alfalfa and grass hays, but sainfoin collected from Erciş area had significantly lower ($P< 0.05$) rate of CP degradation compared with sainfoin samples collected from either Tatvan or Van area (Table 4). The rate of CP degradation was the highest in alfalfa collected from

Van area and the lowest in sanfoin collected from Erciş area among all samples collected from three different areas. Lag time, which indicates the time required for initiation of degradation was significantly higher ($P< 0.05$) in alfalfa collected from Erciş area than those of forages collected from other areas in the study. The low degradation rate indicates the resistance of sainfoin sample collected from Erciş area for ruminal degradation as indicated by numerically low total CP degradation and high escape protein concentration. The rate of CP degradation observed in the study were in the range of result reported for alfalfa (7, 10) and grass (7). Degradation rates of N for alfalfa evaluated in this study were numerically faster than the rates of the grass.While alfalfa samples collected from Tatvan area had significantly lower ($P< 0.05$) WSP and PDP concentrations compared with those of alfalfa samples collected from other locations, the concentrations of NDP and escape protein were similar among alfalfa samples (Table 4). The concentrations of WSP and PDN were significantly lower ($P< 0.05$) in grass samples collected from Tatvan area compared with grass samples collected from either Van or Erciş area. The NDP concentrations of grass samples collected from three different areas significantly differed ($P< 0.05$). Grass samples collected from Erciş area had significantly lower ($P< 0.05$) NDP, escape concentrations than those of grass samples collected from Van and Tatvan areas. The concentrations of PDP, NDP, and escape protein were similar among sainfoin samples collected from three different areas, but WSP concentration of sainfoin collected from Erciş area was significantly greater ($P< 0.05$) than those of sainfoin samples collected from other areas. The concentration of NDP was the lowest in alfalfa samples and EPP was the highest in grass samples when forage species were compared. The concentrations of WSP and PDP for alfalfa were similar to results of Coblentz et al. (7) and Farquhar (10), but the concentrations of NDP for alfalfa were somewhat larger than values reported previously (7, 10). This difference might have been associated with leaf loss during the drying process and maturity differences. Grasses had the greatest variation on the concentrations of WSP, PDN, NPN, and escape protein. Because type of grasses were not determined in these locations, differences in grass species in these locations might have resulted in great variation on WSP, PDN, NPN, and escape protein concentrations. The highest escape protein as percentage of total CP were observed with grasses. Warm season grasses are known to be more resistant to ruminal degradation than cool season grasses (16) or high quality legumes (8). Similarly, Brown and Pitman (3) have reported that degradation rate and thus, escape protein concentrations vary among legumes and grasses, even within legume and grass species.

CONCLUSION

While location in which samples collected had no consistent effect on forage nutritive values, nutritive value of forage species significantly differed. Dry matter, CP degradabilities, CP concentration of alfalfa samples were higher, but the concentrations of NDF, ADF, and ADIN-N were lower, indicating greater nutritive value, compared with grass and sanfoin hays collected from there different areas. When forages were ranked based on nutritive value, alfalfa hays come first. Sanfoin and grass hays follows alfalfa hay, respectively

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